

**Claims:**

What is claimed is:

- 1           1.       A method of coating a surface of a substrate with a polymer  
2       solution, comprising:  
3                        mounting the substrate inside an enclosed housing;  
4                        controlling a solvent vapor concentration of a control  
5       gas by mixing a first solvent vapor-bearing gas with a second gas having a  
6       different solvent vapor concentration;  
7                        passing the control gas into the housing through an  
8       inlet;  
9                        extruding the polymer solution onto the surface of the  
10      substrate in the housing;  
11                      spinning the substrate; and  
12                      exhausting the control gas and any solvent vapor and  
13      particulate contaminants suspended in the control gas from the housing  
14      through an outlet.
- 1           2.       The method of claim 1, wherein the substrate is a wafer having  
2       a top surface, a center, and an outer edge; and  
3                      wherein extruding the polymer solution comprises extruding a ribbon  
4       of photoresist, the ribbon having a width, the ribbon covering the entire top  
5       surface of the substrate in a spiral pattern, wherein the photoresist is extruded  
6       from the extrusion slot at a rate which is a constant extrusion rate, and with the  
7       substrate rotating at a rotational speed, and the extrusion head moving at a  
8       radial speed, the motion of a radially moving extrusion head with respect to

9 the rotating substrate is at a tangential velocity which is a constant tangential  
10 velocity.

1 3. A method according to claim 2, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the outer edge of the  
3 wafer and ending at the center of the wafer.

1 4. A method according to claim 2, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the center of the wafer  
3 and ending at the outer edge of the wafer.

1 5. A method according to claim 2, wherein the width of the  
2 photoresist ribbon is between about one tenth and about one third of the  
3 diameter of the wafer.

1 6. The method of claim 1, wherein:  
2 the substrate is a wafer having a top surface, a center, a diameter, and  
3 an outer edge;  
4 mounting the substrate inside an enclosed housing includes mounting  
5 the wafer on a chuck, the top surface of the wafer aligned horizontally and  
6 oriented upward; and  
7 extruding the polymer solution comprises:

8 positioning an extrusion head adjacent to the outer edge of the wafer  
9 and above the top surface of the wafer, the extrusion head configured to  
10 extrude photoresist out an extrusion slot, the extrusion slot having a length  
11 bounded by a first end and a second end, the extrusion head positioned with  
12 the extrusion slot aligned radially with respect to the wafer, the first end of the  
13 extrusion slot located adjacent to the outer edge of the wafer, and the second  
14 end of the extrusion slot outside the outer edge of the wafer,  
15 rotating the wafer about its center, wherein with the wafer rotating at a  
16 rotational speed, and the extrusion head moving at a radial speed, the motion  
17 of a radially moving extrusion head with respect to the rotating wafer is at a  
18 tangential velocity which is a constant tangential velocity;  
19 extruding a ribbon of photoresist from the extrusion slot, the ribbon  
20 having a width which is substantially equal to the length of the slot, wherein  
21 the photoresist is extruded from the extrusion slot at a rate which is a constant  
22 extrusion rate, and  
23 while extruding photoresist from the extrusion slot, and maintaining  
24 the extrusion slot aligned radially with respect to the wafer, moving the  
25 extrusion head radially inward from the outer edge of the wafer toward the  
26 center of the wafer until the photoresist covers the entire top of the surface of  
27 the wafer.



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1           12.     A method according to claim 11, comprising the steps of  
2           removing the extrusion head, and  
3           rotating the wafer at high speed.

1           13.     The method of claim 1, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3           an outer edge;  
4           mounting the substrate inside an enclosed housing comprises mounting  
5           the wafer on a chuck; and  
6           extruding the polymer solution comprises:  
7           positioning an extrusion head at the center of the wafer and above the  
8           top surface of the wafer, the extrusion head configured to extrude photoresist  
9           out an extrusion slot, the extrusion slot having a length bounded by a first end  
10          and a second end, the extrusion head positioned with the extrusion slot aligned  
11          radially with respect to the wafer, the first end of the extrusion slot located at  
12          the center of the wafer and the second end of the extrusion slot located  
13          between the center of the wafer and the outer edge of the wafer,  
14          rotating the wafer about its center wherein with the wafer rotating at a  
15          rotational speed, and the extrusion head moving at a radial speed, the motion  
16          of a radially moving extrusion head with respect to the rotating wafer is at a  
17          tangential velocity which is a constant tangential velocity,  
18          extruding a ribbon of photoresist from the extrusion slot, the ribbon  
19          having a width substantially equal to the length of the slot, wherein the

20 photoresist is extruded from the extrusion slot at a rate which is a constant  
21 extrusion rate, and  
22 while extruding photoresist from the extrusion slot, and maintaining  
23 the extrusion slot aligned radially with respect to the wafer, moving the  
24 extrusion head radially outward toward the outer edge of the wafer until the  
25 photoresist covers the entire top surface of the wafer.

1 14. The method of claim 1, wherein the first solvent vapor-bearing  
2 gas and the second gas are passed to the housing along conduits in which  
3 electrically-controlled valves are mounted, the valves controlling a gas flow  
4 rate into the housing and the composition of the control gas flowing into the  
5 housing.

1 15. The method of claim 2, wherein the first solvent vapor-bearing  
2 gas and the second gas are passed to the housing along conduits in which  
3 electrically-controlled valves are mounted, the valves controlling a gas flow  
4 rate into the housing and the composition of the control gas flowing into the  
5 housing.

1 16. The method of claim 6, wherein the first solvent vapor-bearing  
2 gas and the second gas are passed to the housing along conduits in which  
3 electrically-controlled valves are mounted, the valves controlling a gas flow







1           28.     The method of claim 2, further comprising passing solvent-free,  
2     humid gas over the coated substrate.

1           29.     The method of claim 6, further comprising passing solvent-free,  
2     humid gas over the coated substrate.

1           30.     The method of claim 13, further comprising passing solvent-  
2     free, humid gas over the coated substrate.

1           31.     The method of claim 27, wherein a humidity of the humid gas  
2     is controlled by means of a temperature and humidity controller.

1           32.     The method of claim 31, wherein the humidity of a humid gas  
2     is controlled to have the relative humidity in the range of 40% to 45%.

1           33.     The method of claim 27, wherein the temperature of the humid  
2     gas is controlled by means of a temperature and humidity controller.

1           34.     A method of coating a surface of a substrate with a polymer  
2     solution, comprising:  
3                     mounting the substrate inside an enclosed housing;  
4                     passing the control gas into the housing through an inlet;

5 extruding the polymer solution onto the surface of the substrate  
6 in the housing;  
7 passing solvent-free dry, filtered gas over the coated substrate;  
8 spinning the substrate; and  
9 exhausting the control gas and any solvent vapor and  
10 particulate contaminants suspended in the control gas from the housing  
11 through an outlet.

1 35. The method of claim 34, wherein the substrate is a wafer  
2 having a top surface, a center, and an outer edge; and  
3 wherein extruding the polymer solution comprises extruding a ribbon  
4 of photoresist, the ribbon having a width, the ribbon covering the entire top  
5 surface of the substrate in a spiral pattern, wherein the photoresist is extruded  
6 from the extrusion slot at a rate which is a constant extrusion rate, and with the  
7 substrate rotating at a rotational speed, and the extrusion head moving at a  
8 radial speed, the motion of a radially moving extrusion head with respect to  
9 the rotating substrate is at a tangential velocity which is a constant tangential  
10 velocity.

1 36. A method according to claim 35, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the outer edge of the  
3 wafer and ending at the center of the wafer.

1           37.     A method according to claim 35, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the center of the wafer  
3 and ending at the outer edge of the wafer.

1           38.     A method according to claim 35, wherein the width of the  
2 photoresist ribbon is between about one tenth and about one third of the  
3 diameter of the wafer.

1           39.     The method of claim 34, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3 an outer edge;  
4           mounting the substrate inside an enclosed housing includes mounting  
5 the wafer on a chuck, the top surface of the wafer aligned horizontally and  
6 oriented upward; and  
7           extruding the polymer solution comprises:  
8           positioning an extrusion head adjacent to the outer edge of the wafer  
9 and above the top surface of the wafer, the extrusion head configured to  
10 extrude photoresist out an extrusion slot, the extrusion slot having a length  
11 bounded by a first end and a second end, the extrusion head positioned with  
12 the extrusion slot aligned radially with respect to the wafer, the first end of the  
13 extrusion slot located adjacent to the outer edge of the wafer, and the second  
14 end of the extrusion slot outside the outer edge of the wafer,

15 rotating the wafer about its center, wherein with the wafer rotating at a  
16 rotational speed, and the extrusion head moving at a radial speed, the motion  
17 of a radially moving extrusion head with respect to the rotating wafer is at a  
18 tangential velocity which is a constant tangential velocity;

19 extruding a ribbon of photoresist from the extrusion slot, the ribbon  
20 having a width which is substantially equal to the length of the slot, wherein  
21 the photoresist is extruded from the extrusion slot at a rate which is a constant  
22 extrusion rate, and

23 while extruding photoresist from the extrusion slot, and maintaining  
24 the extrusion slot aligned radially with respect to the wafer, moving the  
25 extrusion head radially inward from the outer edge of the wafer toward the  
26 center of the wafer until the photoresist covers the entire top of the surface of  
27 the wafer.

1 40. A method according to claim 39, wherein the length of the  
2 extrusion slot is between about one tenth and one third of the diameter of the  
3 semiconductor wafer.

1 41. A method according to claim 39, wherein maintaining the  
2 extrusion slot aligned radially with respect to the wafer further comprises  
3 uniformly maintaining the extrusion slot at a distance above the top surface of  
4 the wafer.



the wafer on a chuck; and

extruding the polymer solution comprises:

positioning an extrusion head at the center of the wafer and above the top surface of the wafer, the extrusion head configured to extrude photoresist out an extrusion slot, the extrusion slot having a length bounded by a first end and a second end, the extrusion head positioned with the extrusion slot aligned radially with respect to the wafer, the first end of the extrusion slot located at the center of the wafer and the second end of the extrusion slot located between the center of the wafer and the outer edge of the wafer,

rotating the wafer about its center wherein with the wafer rotating at a rotational speed, and the extrusion head moving at a radial speed, the motion of a radially moving extrusion head with respect to the rotating wafer is at a tangential velocity which is a constant tangential velocity,

extruding a ribbon of photoresist from the extrusion slot, the ribbon having a width substantially equal to the length of the slot, wherein the photoresist is extruded from the extrusion slot at a rate which is a constant extrusion rate, and

while extruding photoresist from the extrusion slot, and maintaining the extrusion slot aligned radially with respect to the wafer, moving the extrusion head radially outward toward the outer edge of the wafer until the photoresist covers the entire top surface of the wafer.

1           47.     A method of coating a surface of a substrate with a polymer  
2     solution, comprising:  
3                 mounting the substrate inside an enclosed housing;  
4                 passing the control gas into the housing through an inlet;  
5                 extruding the polymer solution onto the surface of the substrate  
6     in the housing;  
7                 passing solvent-free dry, filtered gas over the coated substrate,  
8     wherein a temperature of the solvent-free dry, filtered gas is controlled;  
9                 spinning the substrate; and  
10                exhausting the control gas and any solvent vapour and  
11     particulate contaminants suspended in the control gas from the housing  
12     through an outlet.

1           48.     The method of claim 47, wherein the substrate is a wafer  
2     having a top surface, a center, and an outer edge; and  
3                 wherein extruding the polymer solution comprises extruding a ribbon  
4     of photoresist, the ribbon having a width, the ribbon covering the entire top  
5     surface of the substrate in a spiral pattern, wherein the photoresist is extruded  
6     from the extrusion slot at a rate which is a constant extrusion rate, and with the  
7     substrate rotating at a rotational speed, and the extrusion head moving at a  
8     radial speed, the motion of a radially moving extrusion head with respect to  
9     the rotating substrate is at a tangential velocity which is a constant tangential  
10     velocity.

1           49.     A method according to claim 48, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the outer edge of the  
3 wafer and ending at the center of the wafer.

1           50.     A method according to claim 48, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the center of the wafer  
3 and ending at the outer edge of the wafer.

1           51.     A method according to claim 48, wherein the width of the  
2 photoresist ribbon is between about one tenth and about one third of the  
3 diameter of the wafer.

1           52.     The method of claim 47, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3 an outer edge;  
4           mounting the substrate inside an enclosed housing includes mounting  
5 the wafer on a chuck, the top surface of the wafer aligned horizontally and  
6 oriented upward; and  
7           extruding the polymer solution comprises:  
8           positioning an extrusion head adjacent to the outer edge of the wafer  
9 and above the top surface of the wafer, the extrusion head configured to  
10 extrude photoresist out an extrusion slot, the extrusion slot having a length



11    bounded by a first end and a second end, the extrusion head positioned with  
12    the extrusion slot aligned radially with respect to the wafer, the first end of the  
13    extrusion slot located adjacent to the outer edge of the wafer, and the second  
14    end of the extrusion slot outside the outer edge of the wafer,

15 rotating the wafer about its center, wherein with the wafer rotating at a  
16 rotational speed, and the extrusion head moving at a radial speed, the motion  
17 of a radially moving extrusion head with respect to the rotating wafer is at a  
18 tangential velocity which is a constant tangential velocity;

19 extruding a ribbon of photoresist from the extrusion slot, the ribbon  
20 having a width which is substantially equal to the length of the slot, wherein  
21 the photoresist is extruded from the extrusion slot at a rate which is a constant  
22 extrusion rate, and

23 while extruding photoresist from the extrusion slot, and maintaining  
24 the extrusion slot aligned radially with respect to the wafer, moving the  
25 extrusion head radially inward from the outer edge of the wafer toward the  
26 center of the wafer until the photoresist covers the entire top of the surface of  
27 the wafer.

1            53.      A method according to claim 52, wherein the length of the  
2      extrusion slot is between about one tenth and one third of the diameter of the  
3      semiconductor wafer.





24 extrusion head radially outward toward the outer edge of the wafer until the  
25 photoresist covers the entire top surface of the wafer.

1           60.     A method for coating a surface of a substrate with a polymer  
2 solution, comprising:  
3                   mounting the substrate within an enclosed housing;  
4                   extruding a solvent-bearing polymer solution onto the  
5 substrate; and  
6                   controlling the evaporation of solvent from the polymer  
7 solution by adjusting an amount of solvent introduced into the housing  
8 environment, wherein adjusting the amount of solvent introduced into the  
9 housing environment comprises adjusting a degree of saturation of a control  
10 gas introduced into the housing environment by mixing a plurality of gases  
11 having differing solvent vapor partial pressures to form the control gas.

1           61.     The method of claim 60, wherein the substrate is a wafer  
2 having a top surface, a center, and an outer edge; and  
3                   wherein extruding the polymer solution comprises extruding a ribbon  
4 of photoresist, the ribbon having a width, the ribbon covering the entire top  
5 surface of the substrate in a spiral pattern, wherein the photoresist is extruded  
6 from the extrusion slot at a rate which is a constant extrusion rate, and with the  
7 substrate rotating at a rotational speed, and the extrusion head moving at a

8 radial speed, the motion of a radially moving extrusion head with respect to  
9 the rotating substrate is at a tangential velocity which is a constant tangential  
10 velocity.

1 62. A method according to claim 61, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the outer edge of the  
3 wafer and ending at the center of the wafer.

1 63. A method according to claim 61, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the center of the wafer  
3 and ending at the outer edge of the wafer.

1 64. A method according to claim 61, wherein the width of the  
2 photoresist ribbon is between about one tenth and about one third of the  
3 diameter of the wafer.

1 65. The method of claim 60, wherein:  
2 the substrate is a wafer having a top surface, a center, a diameter, and  
3 an outer edge;  
4 mounting the substrate inside an enclosed housing includes mounting  
5 the wafer on a chuck, the top surface of the wafer aligned horizontally and  
6 oriented upward; and  
7 extruding the polymer solution comprises:

8           positioning an extrusion head adjacent to the outer edge of the wafer  
9   and above the top surface of the wafer, the extrusion head configured to  
10   extrude photoresist out an extrusion slot, the extrusion slot having a length  
11   bounded by a first end and a second end, the extrusion head positioned with  
12   the extrusion slot aligned radially with respect to the wafer, the first end of the  
13   extrusion slot located adjacent to the outer edge of the wafer, and the second  
14   end of the extrusion slot outside the outer edge of the wafer,  
15           rotating the wafer about its center, wherein with the wafer rotating at a  
16   rotational speed, and the extrusion head moving at a radial speed, the motion  
17   of a radially moving extrusion head with respect to the rotating wafer is at a  
18   tangential velocity which is a constant tangential velocity;  
19           extruding a ribbon of photoresist from the extrusion slot, the ribbon  
20   having a width which is substantially equal to the length of the slot, wherein  
21   the photoresist is extruded from the extrusion slot at a rate which is a constant  
22   extrusion rate, and  
23           while extruding photoresist from the extrusion slot, and maintaining  
24   the extrusion slot aligned radially with respect to the wafer, moving the  
25   extrusion head radially inward from the outer edge of the wafer toward the  
26   center of the wafer until the photoresist covers the entire top of the surface of  
27   the wafer.



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1           71.     A method according to claim 70, comprising the steps of  
2           removing the extrusion head, and  
3           rotating the wafer at high speed.

1           72.     The method of claim 60, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3           an outer edge;  
4           mounting the substrate inside an enclosed housing comprises mounting  
5           the wafer on a chuck; and  
6           extruding the polymer solution comprises:  
7           positioning an extrusion head at the center of the wafer and above the  
8           top surface of the wafer, the extrusion head configured to extrude photoresist  
9           out an extrusion slot, the extrusion slot having a length bounded by a first end  
10          and a second end, the extrusion head positioned with the extrusion slot aligned  
11          radially with respect to the wafer, the first end of the extrusion slot located at  
12          the center of the wafer and the second end of the extrusion slot located  
13          between the center of the wafer and the outer edge of the wafer,  
14          rotating the wafer about its center wherein with the wafer rotating at a  
15          rotational speed, and the extrusion head moving at a radial speed, the motion  
16          of a radially moving extrusion head with respect to the rotating wafer is at a  
17          tangential velocity which is a constant tangential velocity,  
18          extruding a ribbon of photoresist from the extrusion slot, the ribbon  
19          having a width substantially equal to the length of the slot, wherein the



20 photoresist is extruded from the extrusion slot at a rate which is a constant  
21 extrusion rate, and  
22 while extruding photoresist from the extrusion slot, and maintaining  
23 the extrusion slot aligned radially with respect to the wafer, moving the  
24 extrusion head radially outward toward the outer edge of the wafer until the  
25 photoresist covers the entire top surface of the wafer.

1 73. The method of claim 60, wherein adjusting an amount of  
2 solvent in the housing environment further comprises creating a uniform flow  
3 of control gas within the housing at a location distal to the substrate, the flow  
4 being substantially normal to the substrate.

1 74. The method of claim 61, wherein adjusting an amount of  
2 solvent in the housing environment further comprises creating a uniform flow  
3 of control gas within the housing at a location distal to the substrate, the flow  
4 being substantially normal to the substrate.

1 75. The method of claim 65, wherein adjusting an amount of  
2 solvent in the housing environment further comprises creating a uniform flow  
3 of control gas within the housing at a location distal to the substrate, the flow  
4 being substantially normal to the substrate.

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1           76.     The method of claim 72, wherein adjusting an amount of  
2     solvent in the housing environment further comprises creating a uniform flow  
3     of control gas within the housing at a location distal to the substrate, the flow  
4     being substantially normal to the substrate.

1           77.     The method of claim 60, wherein the control gas is adjusted to  
2     be saturated with solvent vapor.

1           78.     The method of claim 61, wherein the control gas is adjusted to  
2     be saturated with solvent vapor.

1           79.     The method of claim 65, wherein the control gas is adjusted to  
2     be saturated with solvent vapor.

1           80.     The method of claim 72, wherein the control gas is adjusted to  
2     be saturated with solvent vapor.

1           81.     The method of claim 60, wherein adjusting an amount of  
2     solvent in the housing environment further comprises controlling a liquid  
3     solvent temperature.

1           82.     The method of claim 61, wherein adjusting an amount of

2 solvent in the housing environment further comprises controlling a liquid  
3 solvent temperature.

1 83. The method of claim 65, wherein adjusting an amount of  
2 solvent in the housing environment further comprises controlling a liquid  
3 solvent temperature.

1 84. The method 72, wherein adjusting an amount of solvent in the  
2 housing environment further comprises controlling a liquid solvent  
3 temperature.

1 85. The method of claim 60, wherein adjusting an amount of  
2 solvent in the housing environment further comprises controlling a gas  
3 pressure in a solvent tank.

1 86. The method of 61, wherein adjusting an amount of solvent in  
2 the housing environment further comprises controlling a gas pressure in a  
3 solvent tank.

4 87. The method of claim 65, wherein adjusting an amount of  
5 solvent in the housing environment further comprises controlling a gas  
6 pressure in a solvent tank.

7           88.     The method of claim 72, wherein adjusting an amount of  
8     solvent in the housing environment further comprises controlling a gas  
9     pressure in a solvent tank.

1           89.     The method of claim 60, wherein the control gas is adjusted to  
2     be unsaturated with solvent vapor.

1           90.     The method of claim 61, wherein the control gas is adjusted to  
2     be unsaturated with solvent vapor.

1           91.     The method of claim 65, wherein the control gas is adjusted to  
2     be unsaturated with solvent vapor.

1           92.     The method of 72, wherein the control gas is adjusted to be  
2     unsaturated with solvent vapor.

1           93.     The method of claim 89, wherein the degree of saturation of the  
2     control gas is controlled by varying a control gas temperature.

1           94.     The method of claim 89, wherein varying a control gas pressure  
2     controls the degree of saturation of the control gas.

1           95.     The method of claim 60, wherein controlling the evaporation of

2 solvent from the polymer solution further comprises controlling a solvent  
3 concentration flux within the housing.

1 96. The method of claim 61, wherein controlling the evaporation of  
2 solvent from the polymer solution further comprises controlling a solvent  
3 concentration flux within the housing.

1 97. The method of claim 65, wherein controlling the evaporation of  
2 solvent from the polymer solution further comprises controlling a solvent  
3 concentration flux within the housing.

1 98. The method of claim 72, wherein controlling the evaporation of  
2 solvent from the polymer solution further comprises controlling a solvent  
3 concentration flux within the housing.

1 99. The method of claim 95, wherein the solvent concentration flux  
2 in the housing is controlled by varying a temperature within the housing.

1 100. The method of claim 95, wherein the solvent concentration flux  
2 in the housing is controlled by varying a pressure within the housing.

1 101. The method of claim 95, wherein the solvent concentration flux  
2 in the housing is controlled by varying a solvent velocity within the housing.



1           108. The method of claim 106, wherein a distance separating the  
2 showerhead from the substrate is greater than a distance separating sequential  
3 showerhead orifices by at least a factor of 5.

1           109. A method for coating a surface of a substrate, comprising:  
2 mounting the substrate within an enclosed housing;  
3 extruding a solvent-bearing solution onto the substrate; and  
4 controlling the evaporation of solvent from the solution by adjusting an  
5 amount of solvent introduced into the housing environment, wherein adjusting  
6 the amount of solvent introduced into the housing environment comprises  
7 adjusting a degree of saturation of a control gas introduced into the housing  
8 environment within the range between 0 % and approximately 40%. by mixing  
9 a plurality of gases having differing solvent vapor partial pressures to form the  
10 control gas.

1           110. The method of claim 109, further comprising rotating the  
2 substrate.

1           111. The method of claim 110, wherein the substrate is rotated at a  
2 variable speed.

1           112. The method of claim 110, wherein the substrate is rotated at a  
2 rotational speed of less than approximately 2000 rpm.

1           113.   The method of claim 110, wherein the substrate rotates for a  
2   time sufficient to provide a one sigma film uniformity of no more than 4.0  
3   Angstrom over the substrate.

1           114.   The method of claim 110, wherein the substrate rotates for a  
2   time sufficient to provide a film uniformity of less than 0.05% over the  
3   substrate.